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Improving the shallot and hot pepper cultivation system in the coastal plain of Northern Java

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Improved Vegetable Production and Marketing for small farmers to Increase the Food Security status and to promote Private Sector Development in Indonesia

VegIMPACT is a project financed by The Netherlands' Government promoting improved vegetable production and marketing for small farmers in Indonesia, contributing to the food security status and private sector development in Indonesia. The project builds on the results of previous joint Indonesian-Dutch horticultural development cooperation projects and aligns with recent developments in the horticultural private sector and retail in Indonesia. The project activities (2012 – 2016) include the Development of Product Market Combinations, Strengthening the Potato Sector, Development of permanent Vegetable Production Systems, Knowledge Transfer and Quality systems & Policies

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Summary

The information presented in this paper is based on project results of Hortin II, Supro and Train the Chain activities in the period 2007 - 2012.
A brief description of vegetable cultivation in the Brebes region is given. Also profits of vegetable cultivation are discussed and bottlenecks in the current cultivation system. Possible solutions to improve the cultivation and to enhance farmers income are presented in the last section.
In shallot and hot pepper cultivation a main constraint in the alternating change in land use. With rice cultivation the land is levelled and flooded and with vegetable cultivation raised beds are made. As a result problems are present with soil fertility, hence high fertilizer rates are applied and poor crop growth is present. Another constraint is the small field size per farm, where only at a few days a year harvest takes place. As a result individual farmers are not able to supply year round large quantities and therefore are unable to make arrangements with traders. In case farmers can organize themselves as a group they can produce year round a good quantity making it interesting for traders to make arrangements with this farmers' group.
Based on the conclusions it is proposed to start up activities to address the following topics:

- Permanent vegetable crop cultivation system.
- Year round supply of product and direct linking to a market.

1. Brief description of shallot-hot pepper cultivation in Brebes.

1.1. Location and climate

Brebes is renowned for its shallot production and more than 70%of the total shallot production of Central Java takes place there. Brebes is located between Cirebon and Tegal, adjacent to the Java Sea.

Climate in the region is mostly hot and humid and is characterized by two seasons. From May to November rainfall is low and a lot of effort needs to be put into irrigation. Especially in October and November water levels in ditches and canals can be very low that may cause risks of crop failures because of water shortage. Heavy rains that may occur from November till May frequently result in flooding and high disease pressure. Hence not much hot pepper and shallot is cultivated during that period.

Soil in Brebes is quite heavy, and difficult to cultivate when it is very wet or very dry. The soil contains over 90% clay particles smaller than 16 um. pH of the soil is just below 6 and considered optimal for vegetable crops. Mineral nitrogen content in the soil is quite low as are P_2O_5 levels. Organic matter content is 3.2% and is relatively good due to the rice stubble. Even though, it is not distributed equally throughout the soil but is more or less forming a layer on top of the flat levelled soil present with rice cultivation and underneath the soil put on top of the old rice field when making beds.

Cultivation of shallot (left) and hot pepper (right), note the caisim cultivated on the edges of shallot beds and the presence of quite a lot of yellow leaves in the hot pepper due to virus transmitted by insects.

Planted shallot bulbs, intercrop with hot pepper and intercrop with maize. Note also the placement of fertilizers near the maize plants.

1.2. Cultivation system

Individual farmers rent approximately 1,600 m2 (locally known as 1 bagian) per season. The land rent is about 1,500,000 – 3,000,000 IDR per year (1,000 – 2,000 IDR/m^2). Land rent value is mostly influenced by access to irrigation and by assumed soil fertility status of the field. Land previously used for cultivating sugarcane is considered more fertile, hence more expensive to rent.

In Brebes several crop rotation systems are present. However, raised bed systems for growing vegetables are most frequently alternated with levelled flat land for rice and sugar cane cultivation. Rice is grown by individual farmers, while sugar cane is grown for sugar cane factories who rent land from the community or private land holders (the owners are often publicly unknown).
An example of a rotation system is: rice - shallot – shallot intercrop with hot pepper – bitter gourd or yard long bean. The rice is grown during the wet season and is harvested in the beginning of the dry season. A mono crop of shallot is started afterwards since this is actually the main vegetable crop for farmers in the area. Then, a second shallot crop is grown, either another mono-crop or with hot pepper as intercrop. After hot pepper harvest is completed the stalks and crop debris are left in the field and used for trellising bitter gourd or yard long bean. Those crops are planted as an intercrop with hot pepper. In this way, farmers are using the field as efficient as possible and shortening the total crop period by intercropping. By using the hot pepper stalks they also limit investments in trellis costs.
Other minor crops grown in the region are: eggplant, Mungbean, sweet corn, spinach, kangkung, cucumber, squash and tomato. Planting vegetables (e.g. Caisim) or rice at the edges of the bed with the main shallot crop is also a common practice.

Rice is cultivated on flat land and most of the time during cultivation the land is inundated. Due to this inundation anaerobic conditions occurs, enhancing loss of nutrients and organic matter. Soil structure is also compacted in this way. After rice harvesting, canals are dug at 1.5 m distance and the soil dug out from the canals is put on top of the beds next to the canals. Consequently this soil will be the topsoil for the vegetable cultivation. Soil in Brebes consists heavy clay and is not easy to cultivate. Several times of hoeing is needed to reduce big clay lumps into smaller particles suitable for planting and sowing. For this quite a lot of labour is required (see the paragraph of crop profit).
Beds are approximately 12 meter long and 1.5 m wide, however, considerable ranges in width and length have been observed resulting in quite variation in bed sizes.
About 2.5 ton/ha planting material is required. Taking into account an average yield of 11.7 ton/ha, planting bulbs are actually multiplied 4.6 times in weight. In intercrop cultivation, one week to 10 days after shallot planting hot pepper seeds are sown in between the shallot planting rows. Per position approximately 5 seeds are sown and 1 or 2 out of these will turn into a healthy seedling. Planting material for shallot and hot pepper seeds mostly are obtained from a preceding crop. Small sized shallot bulbs are dried and stored until planting. For hot pepper the best looking fruits are picked and dried. After drying the seeds are taken out of the fruits and after further drying, the seeds are stored in a glass bottle. Use of seedlings is quite uncommon and in case there are some farmers who grow seedlings, the seedlings are mostly sold to other regions.
Irrigation is done manually by scooping up water with a small handheld bucket and spreading the water over the crop. During the cultivation mud is manually lifted from the bottom of the ditches and placed on the edges of the beds. This may prevent run off of fertilizers by irrigation or rain and prevent erosion and maintain the bed size.

Turning flooded rice field into beds for vegetable cultivation.

1.3. Fertilization and crop protection

Shallots and hot peppers are heavily fertilized. Sales promotions and offers by agro-supply shops results in the use of a broad range of different fertilizer types by the farmers. However, urea and ammonium sulphate are generally used, in which the latter is more prevalent in the wet season to avoid nitrogen losses. Nitrogen fertilizers are applied in 3 applications and can be applied broadcasted or placed near plants. Covering fertilizers is rarely taking place although in some cases immediate irrigation may help to the urea to infiltrate in the soil thus may avoid losses due to volatilization. Potassium and phosphorus are also applied at least in 2 applications. Total nitrogen amounts are ranging from 400 to 800 kg N per ha, while phosphorus and potassium are applied at rates of 100 to 200 kg/ha.

A wide range of pests and diseases can occur in both shallot and hot pepper. In shallot mildew and alternaria are important diseases, while thrips, leafminer and spodoptora are important pests.
In hot pepper anthracnose, phytophtohora and cercospora are important diseases. Thrips, white fly, fruit borer, fruitfly and mites are important pests. Generally speaking pests are more of a problem in dry season, while diseases are more of a problem in wet season. In wet season, it is more difficult to apply fungicides because due to weather conditions the fungicides will only be efficient for a shorter period. Insecticide resistance is an issue, efficacy of organophosphate and pyrethroids against pests are doubtful. In order to control pests and diseases and to compensate for resistance, farmers apply a cocktail of pesticides to the crop with 2 to 3 days interval. The cocktail consists of 2 to 3 fungicides and can contain up to 7 insecticides. Commonly farmers apply preventive fungicides, such as mancozeb in shallot and antracol in hot pepper and add a curative fungicide to the mix. For insect control, mostly broad spectrum OP and/or pyrethroids are applied together with more specific newer insecticides. The latter is actually quite expensive. Once a farmer has selected pesticides to be applied in a mix, this mix will be applied each time without any major changes in pesticides combination. Pesticides are applied with a high volume of water due to poor spraying techniques and pesticide applicators. To ensure good coverage of all parts of the plant farmers tend to spray more than is required. Meanwhile, from year to year viruses in hot pepper can pose a big problem. Those viruses are transmitted by mites, thrips and white fly.

Hazardous spraying with a cocktail of pesticides in hot pepper.

1.4. Harvest

Harvest of shallot takes approximately 60 days after planting. Harvested bulbs are either directly sold from the field to a trader or are cleaned and dried by the farmer and sold per kg to a trader at the market. Common also is that shallot farmers have sold their field before the crop has reached harvest stage and is still growing in the field, locally this is called Tebasan.

The yield is averaging about 11 t/ha with the yield range of 5 t/ha to 14 t/ha. Hot pepper is harvested 5 – 6 times, depending on the crop performance. Fruits are sold per kg at the market. Average yield is approximately 11 t/ha, but the yield variation among farms is quite high, ranging from 6 to 25 t/ha. A more in-depth analyse of possible causes of this variation therefore is recommended. This is required also in order to establish planting and harvest schedules for year-round supply.

Harvest, transport and preparing bulbs (drying and removing excess leaves) for selling.

Harvest of hot pepper and selling at market.

2. Income/crop profits

Production costs of shallot – hot pepper in an intercropping system in 2011 were 79.8 (x 1,000,000 IDR) for shallot and 47.7 (x 1,000,000 IDR) for hot pepper, respectively. Thus, the total cost was 127.5 (x 1,000,000 IDR) per hectare. In 2011, the value of shallot sales was 124.8 (x 1,000,000 IDR), while the value of hot pepper sales was 104.7 (x 1,000,000 IDR), providing a total income of 229.5 (x 1,000,000 IDR) per hectare. Therefore, farmers profit per hectare was 102,000,000 IDR/ha. Since the average field size is only about 1600 m^2, a farmer earns 16,320,000 IDR per cultivation. Giving the fact that a maximum of 3 cultivations a year is possible, a farmers yearly income is about 49,000,000 IDR per year (about 3900 Euro).
Based on data collected in 20122, the highest share in cultivation costs is taken by cost of shallot planting bulbs (36%), followed by insecticide costs in hot pepper (17%). Labour costs for shallot are 11% and for hot pepper 10%. Fungicide costs and fertilizer costs per crop are per post less than 5% each in the total costs. However, there is broad range of money spend on inputs per farmer. Planting material costs for shallot as an example was ranging from 36 to 64 (x 1,000,000) IDR/ha. Insecticide costs in hot pepper ranged from 3 to 37 (x 1,000,000) IDR/ha.

Market prices can fluctuate sharply during a year but also from year to year. Hot pepper prices ranged from 4,000 to 25,000 IDR/kg in 2011. Shallot prices in 2011 were fluctuating between 5,000 and 15,000 IDR/kg. With the average market price for hot pepper of 8,000 IDR/kg a farmer's pesticide use can be a determinant factor in making a profit or in making a loss. With shallot cultivation costs of pesticides are lower as compared to the use in hot pepper, but the value is still significant. Especially in shallot cultivation the costs of planting material are high. Farmers are also required to spend a high amount of money at once before starting.

Marketable product which can give good profits, however, market prices are fluctuating a lot.

Shallot and hot pepper cultivation is quite labour intensive. Rice cultivation is less labour intensive than vegetable cultivation. Labour cost of rice cultivation is 23% of the labour cost needed for cultivation of shallot. Changing from a crop rotation system with rice to a permanent vegetable crop system will increase labour demand. Total labour requirement for the intercrop cultivation of shallot and hot pepper is approximately 2000 labour days, of which 50% female labour days. In shallot and hot pepper especially land preparation requires labour when making beds after rice cultivation and accounts for 15% of the total labour need.

3. Addressed issues with previous projects

3.1. Starting material in hot pepper

Currently hot pepper is directly sown between shallot. Five seeds are placed per plant position of which 1 to 2 seeds turn into a healthy plant. This means a quite high loss of seeds. With the currently used OP varieties this does not give major losses in profit since OP seeds are quite cheap. However, when hybrid varieties are introduced, this method is too expensive since hybrid seeds cost more. This is the reason that justifies the need of carrying out transplant raising experiments and demonstration to develop methods for a more efficient seed use.

Achieved results

Some methods have been developed for raising hot pepper seedlings. Information about cheap nurseries, trays choice and soil media to raise transplants are available. Seedlings can be kept healthy and free of pests for 3 weeks when raised in a nursery thus reducing the use of pesticides. With transplants the field period of hot pepper cultivation is shortened also with 3 weeks.

Bottlenecks for introduction

Farmers are not interested in adopting the new raising techniques due to the required investment costs that are not suitable to their cash flow yet. In the meantime, the introduction of hybrid varieties was also hampered due to the absence of positive impacts of these varieties. Secondly due to the inter-cropping system, shortened cultivation period was not able to be achieved. The use of transplants therefore cannot contribute to more efficient land use. Moreover, since shallots are treated with pesticides from day 7, the emerged hot pepper seedlings are indirectly treated as well. Hence, achieved pesticide reduction in the transplant raising phase has little impact on the total farm operation since pesticides are still used in the shallot field anyway.

Healthy seedlings are possible with right starting material and raising material. Especially when wants to cultivate in a net house it is important to start with pest and disease free plants.

3.2 Hybrid varieties

Different hybrid varieties were compared with the traditional OP variety Tit Segitiga. Hybrid varieties were planted at 50% of the OP variety plant density. Lower densities with hybrid varieties are required since seed costs of hybrid varieties and transplant raising costs in nurseries are higher as compared to direct sowing of OP varieties. Nonetheless, the yield level of the hybrid variety was not different to that of the OP variety planted at commonly used planting distance .

Achieved results

Even at lower plant density, hybrid varieties show similar yield to the OP variety. However, the costs of hybrid varieties, even when using direct sowing (lower total costs as compared to transplant raising, even when considering a higher seed loss), was still much higher than the traditional cultivation system of OP varieties. Furthermore in some cases, the fruit size and shape of hybrid varieties was less desirable than the fruits of the OP variety that eventually resulted in a lower market price.

Bottlenecks for introduction

Higher investment costs for the use of hybrid varieties and lack of cash is hampering the introduction in the first place. Additionally, the performance of tested hybrids was a bit disappointing and could not convince farmers to start cultivation with hybrid varieties.

3.3 Starting material in shallot (TSS)

For starting material in shallot bulbs are used kept from previous cultivation. These bulbs are air dried, cleaned from excess leaves and stored till the next cultivation. Quality control is only carried out by visual observation of the bulbs in which rotten and infected bulbs are rejected. Internal quality control on presence of pests and diseases does not take place. Before planting bulbs are treated with a fungicide (mostly mancozeb at a rate of 1 g per 0.5 kg bulbs) in order to prevent soil borne fungal diseases, however, this treatment does not prevent fungal diseases already present in the bulb. Degeneration of the planting material is present and in combination with poor quality of the bulbs, yield achieved is less than possible levels (potential yield). In true shallot seeds (TSS) cultivation, high quality seeds of high yielding varieties and free of pests and diseases, are used as starting material. In this case seedlings need to be raised from the seeds, since direct sowing is not possible in the heavy clay soil without losing a high amount of seeds.

Achieved results

Methods for raising seedlings have been developed.Plant density recommendation for TSS shallot cultivation has been formulated as well. Furhtermore, a new variety with a higher yield potential, disease resistance, grading and earliness has also been introduced. Markets that are dominated by shallot from Bima Curut variety seems to respond equally well to shallot bulbs from TSS. Shallot cultivation by using TSS is proven to be more profitable than shallot cultivation by using local variety Bima Curut.

Bottlenecks for introduction

In TSS cultivation farmers need to invest in more expensive seeds, expensive varieties and nurseries to raise transplants. In the meantime farmers need to be convinced about the advantages of this method. Risks of crop failure due to climatic conditions are high as assessed by farmers. Consequently, they are reluctant to invest in this shallot cultivation system. Another issue also considered as constraint is the seed availability. Furthermore, farmers also need more labour to raise the seedlings and to transport them in a proper way into the field for planting.

3.4 Protected cultivation (net house)

Cultivation in the open field is hampered by climatic conditions and high pest pressure. When growing hybrid varieties in combination with expensive transplants, it is important to keep the plants healthy in order to benefit from its full production potential. The impact of losing one plant from hybrid varieties cultivation at lower plant densities is much bigger as compared to losing one plant of an OP variety cultivated at higher plant densities. For this reason, farmers are spending quite a lot of money on crop protection. However, the applications are done in such a way that it is harmful to the user and to the labor. In addition, excessive use of pesticides is polluting the water and soil, and endangering the environment and drinking water supply.

One way to reduce the impact of climate and pests is the use of simple net house constructions. The net/screen can function as a barrier to the plants, especially from larger insect pests such as caterpillars. In the case of small insects, such as mites, white fly and thrips, the screen may reduce the population to such extent that those pests can be controlled with less pesticides as compared to open field cultivation.

Achieved results

Net house cultivation has demonstrated that less pesticide is needed for a good crop growth. However, shallot cultivation in a net house showed lower yield than in the open field. Most likely the lower shallot yield is caused by reduced light levels and prolonged leaf wetness period resulting in reduced growth and higher disease pressure. However, hot pepper cultivation in the net house showed a significant increase in yield, that is from 5 t/ha in the open field to 25 t/ha or more in the net house.

Bottlenecks for introduction

Since shallot is the main crop for the farmers in Brebes, solutions need to be found for improving shallot yield in the net house. Investment in a net house is restricted due to limited cash availability of the farmers. In order to make the net house more profitable, quick cultivation turn-over needs to be achieved. Short periods between cultivations need to be promoted and the use of transplants should be recommended since it can shorten the cultivation period in the net house. Higher profits are expected because of the possibility of having more crop cycles.

Net house cultivation as a solution to reduce pesticide use.

3.5. Fertilizer and pesticide use

In shallot-hot pepper intercropping cultivation, excessive levels of fertilizer and pesticides are applied. High levels of fertilizers are applied to compensate for the limited root system development due to poor soil structure. Rates up to 870 kg/ha nitrogen, 230 kg/ha phosphorus and 520 kg/ha potassium are common practice. Not only high amount of both inputs are applied but also the variation of fertilizer/pesticide-use among farms is quite high. Demo-plots have shown farmers the effect of crop growth with 20% less nitrogen and 48% less potassium as compared to the average farmers' practices. Simultaneously farmers also received training on some topics in fertilization, such as how to reduce the amounts, why fertilization is needed, what the crop needs, how to select proper fertilizers and when the best timing is for application.

Pesticide use and especially insecticide use is quite high. Standard procedure (common practice) is to spray every 3 days in shallot and every 2 days in hot pepper. Pesticide cocktail is used for spraying in shallot, while different cocktail is selected for hot pepper. A cocktail contains more or less 7 pesticides (2 fungicides and 5 insecticides). According to farmers, a spreader is often added to enhance efficacy. Farmers were also trained on the proper use of pesticides. The training was focused on some topics, such as controlling spectrum of pesticides and discouraging the application of cocktails containing pesticides with the same mode of action. A cocktail containing less pesticide has been proven to have similar effectiveness. Another issue dealt with was the issue of pest resistance against pesticides. Farmers were trained to alternate the use of pesticides in a particular season to avoid resistance build-up. Moreover, demo-plots of shallot-hot pepper intercropping cultivation were also organized to show farmers that less pesticide-use may also result in similar yield levels as compared to common farmers' practices.

Achieved results

After receiving training farmers have changed their practice to a more rational fertilizer-use resulting in a significant cost reduction of 25%. However, from the agronomic perspectives, the changes are still higher than the required levels under optimal conditions.

Pesticide use was reduced by reducing the number of pesticides in a cocktail. Farmers have also learned better spraying techniques for reducing water spraying volume that finally may also reduce the amount of pesticide needed. However, there is still no indication that farmers have reduced their frequency of application. Taking into account some aforementioned changes in farmers' practices, the costs of pesticide-use have been reduced by about 20%.

Bottlenecks for introduction.

Soil conditions are still poor due to the crop rotation with rice where fields are flooded and after that beds are made. The heavy clay takes some time to settle and to create optimal rooting conditions. As a

result higher fertilizer levels than actual crop needs are required to compensate for the reduced uptake capacity of the plants.
Heavy pest and disease pressures are still the biggest problem. Due to limited crop growth, plants also have difficulties to compensate losses because of pest attacks. In Brebes area, fast build-up of pest populations and short cycles of insects and diseases are present. New generations of pests have emerged only within days.

3.6. Year round supply and organization of farmers

The average individual farm size is about 1600 m^2. Farmers usually plant the complete field with a crop at once. This results in a one period harvest of product. It imposes high risk for farmers since their profit solely depends on the prevailing market price for a particular single period. This system will not be functioning quite well for linking farmers to markets since traders would frequently like to make agreements for continuous supply only. For those reasons activities have been carried out to organize farmers into a farmer group. The group consisted of 15 farmers has been involved in a pilot study to produce year round - fixed amount of shallot and hot pepper.

Results
The farmers noticed that as a group they might have more capacity and opportunity to arrange direct marketing with traders. Farmers were willing to cooperate and follow planting schemes in order to guarantee year round supply. Experience from shallot pilot study suggests that to a certain extend a weekly supply might be possible.

Bottlenecks for introduction
So far no fixed agreements could be made between farmers and trader(s). Therefore to the farmers it is unsure whether their activities will pay off. Will they achieve a better income when dealing directly with a trader remains a question. Another issue still is the weekly production and actual timing of harvest. This needs to be fine-tuned still in order to supply exactly each week the exact amount of required product. Although an informal farmers group has been established this needs to be formalized first. The farmers have to establish a joint venture and arrange agreements for the group members.

3.7. Permanent vegetable crop rotation system

Stakeholders were interviewed on their opinion regarding the introduction of a permanent vegetable cultivation system. Besides shallot and hot pepper, some information on other vegetable crops that could be included in the cultivation system was also collected. Furthermore, the possibility of using upland rice as an alternative to flooded rice was also elaborated.

Achieved results
Crop profits, optimum growing season and risk of cultivation were established. By introducing the permanent vegetable crop cultivation system, it is expected that soil structure and soil fertility will be improved. It is also expected that the system will result in higher yields with less input use. Moreover, the use of less labor is also possible since the beds construction is a onetime activity and does not need to be done every time after rice cultivation. Stakeholders are quite optimistic with the idea of introducing a permanent vegetable cultivation system.

Bottlenecks for introduction
So far no crop rotation sequence has been developed and tested (type of crop, growing period). Uncertainties about the feasibility of a crop cultivation system are withholding farmers from trying. Firstly, they would like to see the performance and feasibility of this system based on field demonstrations/experiments. Secondly, the complete calculation of the system' exact profitability needs to be determined. Finally, some issues such as food security, exclusion of high yielding flooded rice, and farmers' responses to this new system idea, should also be addressed. Dry land rice might be an alternative but it should be anticipated that it will result in lower yields and therefore reducing the profitability of a new crop rotation system. Nevertheless, the flooded rice maybe is still required to be included in every particular period of, for instance every 5 years, in order to reduce the soil borne pests and diseases.

3.8. Training of farmers

Farmers have been receiving trainings on shallot and hot pepper cultivation. Main topics included in the trainings were the use of planting material, fertilizer use, pesticide use and net house cultivation. Besides emphasizing on the agronomic materials, the training also included the economic evaluation of recommended cultivation practices - the impacts of introducing new techniques on farmers' profit/ income. Trainings were mostly organized as bi-weekly meetings in the field where farmers received practical training and had to do hands-on activities. Other methods used were organizing farmers meetings at venues where presentations were given and discussed. Finally, field days were organized where larger and broader audience was invited to observe results of demonstrations and experiments.

Achieved results

Trainings have resulted in increased farmers' knowledge on cultivation techniques. Trainings were also quite successful in increasing farmers' awareness in keeping track of costs and income to establish profits. Based on increased knowledge obtained from the trainings, farmers were able to cut back costs in their shallot and hot pepper cultivation. Trainings have also helped farmers to be able to develop a more rational fertilizer use and crop protection schedule.

Bottlenecks

Training programs were mostly quite short, meanwhile it required some time or longer time for convincing farmers in the area. Theoretical training materials should be supported by more field demonstrations and opportunities to assist farmers with new techniques on their own fields.

Practical training of farmers and demonstration fields are needed to convince farmers about techniques to improve vegetable cultivation.

4. Summary of bottlenecks in vegetable cultivation

Heavy soil and crop rotation

The area where the shallot an hot pepper cultivation takes place and were the experiments and demonstrations were organized is a coastal plain with heavy clay. This soil type has limitations for vegetable cultivation due to its characteristics. The soil is hard to cultivate. In wet conditions, the soil is not tillable and during cultivation heavy rain and excess water can lead to anaerobic conditions in the root zone. In dry conditions the soil is too hard to cultivate. Clay lumps will break but not into nice fine particles. The problems are getting deepened by the existing crop rotation system that involves land flooding for rice production and land bedding for vegetable production. Immediately after bed making, a compact layer is present in the soil. In a way, organic matter is actually applied to the beds from the rice crop debris, even though it is not uniformly mixed throughout the root zone. This organic matter remains at the original field level where the rice was grown underneath the soil that has been turned on top when making beds. The soil also takes some time to settle after bed making. This disturbs root growth and reduces crop growth that consequently tends to demand higher amount of fertilizers.

Heavy infestation by insects and fungal diseases

Due to the hot and humid climate, a lot of diseases and pests are present. High disease pressures and intensive spraying tend to fasten population build-up. High temperature shortens the generation cycles of both insects and fungal diseases. Therefore, the effect of a pesticide application is not long lasting. The improper use of pesticides has been suspected to result in high level of pest and disease resistance to a group of pesticides.

Small fields

The average individual farm size is quite small, about 1600 m2. The advantage of this small size of farms is that most of the time farmers themselves can handle the farm works and they only have to hire labor for land preparation, planting/sowing and harvest. A disadvantage of the small size, however, is that the harvested product is mostly sold in a limited period of time, thus imposes a risk in terms of market price which is highly volatile. Another disadvantage is that the farmer only can supply to the market at a limited period of time as well. Direct marketing therefore is not possible since a trader only likes to make agreements with a party when a guaranteed year round supply is possible.

Production levels

The average yield of either shallot or hot pepper is approximately 11 t/ha. Comparing to other regions, shallot yield level is quite high, but hot pepper yield level is lower. It seems that there are still some possibilities to improve the current yield level by improving cultural practices and other conditions. Better soil structure, improved fertilization schedules and better pest control methods could enhance yield levels. However, the average yield data should be used cautiously since the yield variation among farmers is quite high.

Record keeping

Farmers are usually not keeping records hence they do not know how much money they exactly spend on crop cultivation. They mostly do not know the real profits they earn and are having difficulties to calculate how much they can invest in new techniques. Lack of records has also created some difficulties to evaluate crop cultivation methods.

Knowledge

Farmers are well aware of allocating inputs in traditional shallot and hot pepper cultivation. However, they still heavily rely on advices from local input-retailers. Therefore it seems that they are more into controlling symptoms rather than trying to solve causes of symptoms. Knowledge about fertilization, pesticides, and certainly regarding crop rotation and systems is still limited. Given those conditions, however, farmers are keen to learn about proper use of inputs and new ideas.

5. Conclusions / recommendations

Permanent vegetable cultivation systems

Based on the analysis of current cultivation system and bottlenecks, it seems that a new crop rotation system can enhance the productivity of vegetable crops. Furthermore, rice cultivation needs less labour than vegetable cultivation. Thus a permanent vegetable cultivation system will enhance labour opportunities. Therefore, the introduction of a new production system is really recommended. However, there are several things that should be carefully considered and addressed during the introduction

- Use of healthy starting material where ever possible in order to use the land most efficiently
- Inclusion of net house / shelter cultivation (permanent or easily moved to other locations) in the crop rotation in order to produce vegetables with low pesticide use.
- Selection of vegetable crops and sequences that are in line with agronomic principles and offer the highest possible profits.
- Possible inclusion of "dry" rice or "edge" rice cultivation for own consumption.
- Land ownership – farmers are renting land that mostly should be renewed every year, consequently they also have to work on different farm locations every year - soil improvement technology that requires long-term process is becoming difficult to be transferred and adopted.

Direct linking to markets

To reduce risks of low market prices, it is essential for farmers to make direct arrangements with traders. However, this arrangement cannot be carried out if farmers do not have commitments to unite in a group. Farmers should be working collectively based on required production plan in order to weekly supply the same amount and the same quality of vegetables. Issues to be addressed are:

- Formalizing the farmers organization
- Contract arrangements with trader
- Financial arrangements (payment to farmers)
- Establishing a production plan (who, when and how much to produce)
- Quality control of the cultivation and product
- Storage and transport

6. Workshop with stakeholders

A presentation based on this report and a synthesis of past activities and technical achievements is proposed. It will be presented during a workshop with farmers, traders, extension service officers and researchers. Results of previous activities should be discussed and more importantly ideas and suggested solutions for improvements should be formulated. Furthermore, possible crop rotations that will be included in the permanent vegetable crop systems need to be discussed and developed.